Seabed Geoacoustic Planning Support for the QPE Uncertainty DRI

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LONG TERM GOALS

Develop capability for quantifying, predicting and exploiting (QPE) the impact of seabed uncertainty on sonar system performance.

OBJECTIVES

The objectives were to contribute to the development of a science plan for the QPE DRI that builds on the recent advances in the understanding of uncertainty.

APPROACH

Assisted in shaping science plan drawing on the open literature, Taiwanese and other QPE colleagues, in close collaboration with members of the Seabed Characterization Working Group including Larry Mayer and Brian Calder (University of New Hampshire), Jim Lynch (WHOI), Bob Miyamoto (APL-UW) as well as Phil Abbot (team leader for Acoustics Working Group).

WORK COMPLETED

1) Helped identify/obtain in southern East China Sea, pertinent to DRI goals

- key results from geologic/geophysical/geoacoustic community
- key missing elements of seabed characterization
- methods for quantifying and predicting geoacoustic uncertainty

2) Provided guidance on seabed uncertainty and variability issues in order to develop goals and a roadmap for the ensuing 4-year DRI.

RESULTS

Unknown acoustic boundary conditions at the seabed lead to large uncertainties in TL and noise predictions. Spatial and possibly temporal (see features discussed below) variability will increase those uncertainties. A literature search was performed to identify seabed processes and features that might play a significant role in acoustic performance uncertainty. A short summary follows.

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The seabed processes that appear to be important are:

- Erosion, enhanced by seismicity, landslides (sub-aerial and submarine) leading to riverine sediment deposition (e.g., Lanyang Hsi, NE Taiwan). This region is somewhat unique inasmuch as Taiwan supplies ~400 Mtons/year of sediment to the ocean which is ~2% of the total worlds sediment discharge, yet Taiwan only accounts for ~0.02% of the earths' exposed surface.

- Sediment transport across the ECS shelf from the Yangtse river around NE tip of Taiwan. The importance and exact path of this transport is under debate. These are fine-grained sediments that eventually end up in the Southern Okinawa Trough.

- Biogenic contributions: Shell material is abundant at the shelf edge and upper slope is generally associated with sandy sediments. Muddy sediments also contain 25%-40% CaCO3 from planktonic foraminfera and pteropod shells associated with upwelling.

- Rock fragments are common and abundant constituents of all shelf sands, with a relative abundance of sandstone clasts.

- The ECS shelf is strongly shaped by glacio-eustasy, alternating continental and marine sediments corresponding to glaciation and interglaciation are evident.

- The Southern Okinawa Trough (SOT) is shaped by sediment transported by currents from China (Yangtse), Taiwan, and equatorial Pacific. While SOT is only 10% of entire OT, it contains the majority of OT sediments. Mass wasting events are an extremely important in the SOT and greatly contribute to the complexity of the area.

- The Kuroshio Current seems to play a role in the distribution of sediments under/near its path. There are sediment "mixtures" probably associated with loop currents on the shelf and directional changes of the Kuroshio. Beneath the main Kuroshio flow, sediments are non-biogenic fine-grained mud.

There are several seabed features that may have important implications including:

- Tidal induced sand ridges (left from the postglacial sea level rise): tidal currents are high, > 1 m/s in some areas, and 0.75 cm/s at the shelf break. There is strong evidence of large sand ridges on the Chilung shelf that appear to variable over seasonal time scales.

- On outer shelf and slope, presence of deep thermogenic methane leads to mud volcanoes (5-40 m in height; radii ~20-600 m have been observed) and pockmarks; (up to 40m in depth, radii up to 150m). Besides the bathymetric expression, the presence of gas drastically alters seabed physical properties relative to the surrounding sediments. Some of the mud volcanoes are expected to be "active" meaning that they are actively venting methane (e.g., in bubble plumes) and/or oil into the ocean. Very little is known about the temporal scales associated with the methane fluxes.

IMPACT/APPLICATIONS

The study was useful inasmuch as it provides a basis for developing goals and a roadmap for the ensuing 4-year DRI. An important question that will be addressed in the follow-on program is how do uncertainties in bottom geoacoustic properties and morphology affect uncertainty in acoustic performance prediction (propagation, noise, and coherence).

RELATED PROJECTS

none